Occupational Safety and Health Guideline for Zirconium & Compounds

DISCLAIMER:

These guidelines were developed under contract using generally accepted secondary sources. The protocol used by the contractor for surveying these data sources was developed by the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the Department of Energy (DOE). The information contained in these guidelines is intended for reference purposes only. None of the agencies have conducted a comprehensive check of the information and data contained in these sources. It provides a summary of information about chemicals that workers may be exposed to in their workplaces. The secondary sources used for supplements III and IV were published before 1992 and 1993, respectively, and for the remainder of the guidelines the secondary sources used were published before September 1996. This information may be superseded by new developments in the field of industrial hygiene. Therefore readers are advised to determine whether new information is available.

Introduction

This guideline summarizes pertinent information about zirconium and zirconium compounds (measured as zirconium) for work and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

Applicability

This guideline applies to zirconium and to zirconium compounds. Examples of some zirconium compounds are zirconium acetal zirconium boride, zirconium carbide, zirconium carbonate, zirconium disulfide, zirconium glycolate, zirconium hydride, zirconium hydroxide, zirconium nitrate, zirconium oxide, zirconium oxychloride, zirconium phosphate, zirconium sulfate, zirconium tetrachloride, and zirconyl acetate. For illustrative purposes, the physical and chemical properties of zirconium and of several zirconium compounds are presented below.

Recognition

Zirconium

SUBSTANCE IDENTIFICATION

* Formula

Zr

* Structure

(For Structure, see paper copy)

* Synonyms

Zircat, zirconium metal

* Identifiers

1. CAS 7440-67-7

2. RTECS ZH7070000

3. DOT UN: 1208 27

4. DOT UN: 1308 26, 1358 32, 2008 37, or 2009 37, depending on the form of this substance

* Appearance and odor

Zirconium is a grayish-white, lustrous, odorless metal; when powdered, it is bluish black. It is available commercially in powder, sponge, plate, strip, bar, wire, briquette, and foil forms.

CHEMICAL AND PHYSICAL PROPERTIES

* Physical data

1. Atomic number: 40

2. Atomic weight: 91.2

3. Boiling point (760 torr): 4377 degrees C (7910.6 degrees F)

4. Specific gravity (water = 1): 6.5 at 20 degrees C (68 degrees F)

5. Vapor density: Not applicable

6. Melting point: 1830 degrees C (3326 degrees F)

7. Vapor pressure at 20 degrees C (68 degrees F): Not applicable

8. Solubility: Soluble in hydrofluoric acid, aqua regia, and alcohol

9. Evaporation rate: Not applicable

Zirconium oxide

SUBSTANCE IDENTIFICATION

* Formula

ZrO(2)

* Structure

(For Structure, see paper copy)

* Synonyms

Zirconia, zirconium dioxide, zirconium anhydride, zirconic anhydride

* Identifiers

1. CAS 1314-23-4

2. RTECS: None

3. Specific DOT number: None

4. Specific DOT label: None

* Appearance and odor

Zirconium oxide is a heavy, white, odorless powder.

CHEMICAL AND PHYSICAL PROPERTIES

* Physical data

1. Molecular weight: 123.2

2. Boiling point (760 torr): 5000 degrees C (9032 degrees F)

3. Specific gravity (water = 1): 5.6 to 5.9 at 20 degrees C (68 degrees F)

4. Vapor density: Not applicable

5. Melting point: 2715 degrees C (4919 degrees F)

6. Vapor pressure at 20 degrees C (68 degrees F): Negligible

7. Solubility: Insoluble in water; soluble in hydrofluoric acid or aqua regia

8. Evaporation rate: Not applicable

Zirconium oxychloride

SUBSTANCE IDENTIFICATION

* Formula

ZrOCl(2)*8H(2)O

* Structure

(For Structure, see paper copy)

* Synonyms

Zirconyl chloride, zirconyl chloride octahydrate, zirconium oxide chloride, chlorozirconyl, dichlorooxozirconium

* Identifiers

1. CAS 7699-43-6

2. RTECS ZH7700000

3. Specific DOT number: None

4. Specific DOT label: None

* Appearance and odor

Zirconium oxychloride is an odorless, yellow to white solid.

CHEMICAL AND PHYSICAL PROPERTIES

* Physical data

1. Molecular weight: 322.3

2. Boiling point (760 torr): Loses 8 of its waters at 210 degrees C (410 degrees F)

3. Specific gravity (water = 1): Greater than 1 at 20 degrees C (68 degrees F)

4. Vapor density: Not applicable

5. Melting point: Loses 6 of its waters at 150 degrees C (302 degrees F)

6. Vapor pressure at 20 degrees C (68 degrees F): 9 to 13 torr

7. Solubility: Soluble in cold water, alcohol, and ether; decomposes in hot water

8. Evaporation rate: Not applicable

Zirconium tetrachloride

SUBSTANCE IDENTIFICATION

* Formula

ZrCl(4)

* Structure

(For Structure, see paper copy)

* Synonyms

Zirconium chloride

* Identifiers

1. CAS 10026-11-6

2. RTECS ZH7175000

3. DOT UN: 2503 39

4. DOT label: Corrosive

* Appearance and odor

Zirconium tetrachloride is a noncombustible, white, lustrous solid that has an acrid odor in moist air.

CHEMICAL AND PHYSICAL PROPERTIES

* Physical data

1. Molecular weight: 233

2. Boiling point (760 torr): 331 degrees C (628 degrees F) (sublimes)

3. Specific gravity (water = 1): 2.8 at 20 degrees C (68 degrees F)

4. Vapor density: Not applicable

5. Melting point: 437 degrees C (818.6 degrees F)

6. Vapor pressure at 20 degrees C (68 degrees F): Very low

7. Solubility: Reacts with water to form hydrogen chloride; decomposes in hot water; soluble in alcohol, ether, and concentrated hydrochloric acid

8. Evaporation rate: Not applicable

Zirconium hydride

SUBSTANCE IDENTIFICATION

* Formula

ZrH(2)

* Structure

(For Structure, see paper copy)

* Synonyms

Zirconium dihydride

* Identifiers

1. CAS 7704-99-6

2. RTECS ZH8015000

3. DOT UN: 1437 40

4. DOT label: Flammable Solid, Dangerous When Wet

* Appearance and odor

Zirconium hydride is a flammable, odorless, dark grey to black, metallic powder.

CHEMICAL AND PHYSICAL PROPERTIES

* Physical data

1. Molecular weight: 93.2

2. Boiling point (760 torr): Decomposes

3. Specific gravity (water = 1): 5.6 at 20 degrees C (68 degrees F)

4. Vapor density: Not applicable

5. Melting point: Decomposes above 300 degrees C (572 degrees F)

6. Vapor pressure at 20 degrees C (68 degrees F): Negligible

7. Solubility: Reacts with water; soluble in hydrofluoric acid or alcohol

8. Evaporation rate: Not applicable

Zirconyl acetate

SUBSTANCE IDENTIFICATION

* Formula

Zr(OH)(2)(C(2)H(3)O(2))(2)

* Structure

(For Structure, see paper copy)

* Synonyms

Diacetatozirconic acid; bis(acetato-o,o')oxo-zirconium

* Identifiers

1. CAS 20645-04-9

2. RTECS ZH7100000

3. Specific DOT number: None

4. Specific DOT label: None

* Appearance and odor

Zirconyl acetate is a colorless, tacky, resinous, amorphous solid.

CHEMICAL AND PHYSICAL PROPERTIES

* Physical data

1. Molecular weight: 225.3

2. Boiling point (760 torr): Decomposes

3. Specific gravity (water = 1): 1.46 at 20 degrees C (68 degrees F)

4. Vapor density: Not applicable

5. Melting point: Data not available

6. Vapor pressure at 20 degrees C (68 degrees F): Very low

7. Solubility: Very soluble in water

8. Evaporation rate: Not applicable

* Reactivity

1. Conditions contributing to instability vary with the form of zirconium or with the specific zirconium compound. Powdered zirconium and zirconium borings and shavings are highly flammable and may ignite spontaneously in air. In contact with water, zirconium tetrachloride reacts vigorously to form hydrogen chloride; this substance also ignites spontaneously in air. Zirconium hydride is a flammable solid; in powdered form, it can ignite and explode if exposed to heat, fire, or sparks.

2. Incompatibilities: Contact of zirconium with borax, carbon tetrachloride, potassium chlorate or nitrate, cupric or lead oxides, and heating with alkali metal hydroxides or carbonates can cause explosions. Contact of zirconium hydride with water, acids, oxidizers, or halogenated compounds may cause a violent reaction. Contact of zirconium tetrachloride with water or moisture in the air forms hydrochloric acid.

3. Hazardous decomposition products: Toxic gases and vapors may be released in fires involving zirconium or its compounds. When zirconium hydride is heated or comes into contact with water, acids, oxidizers, or halogenated compounds, it evolves flammable and explosive hydrogen gas. When zirconium tetrachloride, zirconium oxychloride, or zirconium dichloride is heated to decomposition, chlorine gas is evolved.

4. Special precautions: Zirconium tetrachloride attacks some coatings and some forms of plastic and rubber.

* Flammability

The National Fire Protection Association (NFPA) has assigned a flammability rating of 4 (extreme fire hazard) to zirconium in powdered form. Zirconium hydride's fire hazard is rated by another source as slight [Genium MSDS 1987, No. 212], and neither zirconium oxide nor zirconium tetrachloride is flammable. No information is available on the flammability of the other zirconium compounds highlighted in this guideline.

1. Flash point: Not applicable

2. Autoignition temperature: For zirconium, the autoignition temperature varies with particle size: for 18-m particles, it is approximately 350 degrees C (662 degrees F); however, 3-m particles are reported to have a high autoignition potential. For zirconium hydride, the autoignition temperature is 270 degrees C (518 degrees F).

3. Flammable limits in air: Not applicable

4. Extinguishant: For a fire involving zirconium powder, do NOT use water, carbon dioxide, halocarbon, or soda ash extinguishants; use dry sand, Fuller's earth, or a proprietary metal fire extinguishant. For a fire involving zirconium hydride, do NOT use water, carbon dioxide, or halocarbon-based extinguishing agents; use powdered limestone (dolomite), dry sand, graphite powder, or a proprietary metal fire extinguishant. For a fire involving zirconium oxide or zirconium tetrachloride, use

an extinguishant that is suitable for the material involved in the surrounding fire.

Fires involving zirconium or zirconium compounds should be fought upwind and from the maximum distance possible. Keep unnecessary people away; isolate hazard area and deny entry. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Explosion hazards may occur indoors, outdoors, or in sewers. Containers of powdered zirconium or zirconium compounds may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Personnel should withdraw immediately if a rising sound from a venting safety device is heard or if there is discoloration of a container due to fire. Dikes should be used to contain fire-control water for later disposal. If a tank car or truck is involved in a fire, personnel should isolate an area of a half a mile in all directions. Firefighters should wear a full set of protective clothing, including a self-contained breathing apparatus, when fighting fires involving powdered zirconium or a flammable or combustible zirconium compound.

* Warning properties

Zirconium and most zirconium compounds are odorless; these substances are therefore considered to have inadequate odor warning properties.

* Eye irritation properties

No quantitative data are available on the eye irritation threshold for zirconium or zirconium compounds; however, these substances are not known to be eye irritants.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) for zirconium and zirconium compounds (measured as zirconium) are 5 milligrams per cubic meter (mg/m(3)) of air as an 8-hour time-weighted average (TWA) concentration and 10 mg/m(3) as a 15-minute TWA short-term exposure limit (STEL). A STEL is the maximum 15-minute concentration to which workers may be exposed during any 15-minute period of the working day [29 CFR 1910.1000, Table Z-1-A]. The National Institute for Occupational Safety and Health (NIOSH) has not issued a recommended exposure limit (REL) for zirconium and zirconium compounds. The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned zirconium and zirconium compounds (measured as zirconium) threshold limit values (TLVs) of 5 mg/m(3) as a TWA for a normal 8-hour workday and a 40-hour workweek and a short-term exposure limit (STEL) of 10 mg/m(3) for periods not to exceed 15 minutes [ACGIH 1988, p. 43]. The OSHA and ACGIH limits are based on the risk of pulmonary effects associated with exposure to zirconium or its compounds.

Evaluation

HEALTH HAZARD INFORMATION

* Routes of Exposure

Exposure to zirconium and zirconium compounds can occur via inhalation, ingestion, and eye or skin contact.

* Summary of toxicology

1. Effects on Animals: Inhalation of the dust of zirconium compounds has caused pulmonary granulomas in experimental animals. The oral LD(50)s for zirconium compounds range from 1.7 to 10 g/kg, depending on the compound [Proctor, Hughes, and Fischman 1988, p. 517]. In rats, the intraperitoneal LD(50) for zirconyl acetate is 400 mg/kg, while the oral LD(50) for the same substance is 4100 mg/kg [RTECS 1989c; Clayton and Clayton 1981, p. 2054]; the intraperitoneal toxicity both of the inorganic and organic compounds of zirconium is approximately 20 times greater than their oral toxicity [Clayton and Clayton 1981, p. 2054]. Animals acutely poisoned with zirconium show progressive depression and decreasing activity before death [Clayton and Clayton 1981, p. 2054]. Exposure to zirconium lactate or barium zirconate at airborne concentrations greater than 5 mg/m(3) produced severe, chronic, interstitial pneumonitis in laboratory animals [Parmeggiani 1983, p. 2343]. Daily 20-minute inhalation exposures to an unspecified concentration of the mist of sodium zirconium lactate for 6 weeks produced bronchial abscesses (with lobar pneumonia) or peribronchial granulomas in rabbits [Clayton and Clayton 1981, p. 2055]. Intensive (not further specified) exposure of rats to the dust of zirconium silicate for 7.5 months produced shadows on the lungs radiographically, but no histologic changes were seen in these animals at autopsy [Clayton and Clayton 1981, p. 2955]. Several inhalation studies involving animals of different species and exposure for 1 year either to zirconium oxide dust or zirconium tetrachloride mist (at a zirconium concentration of 3.5 mg/m(3)) measured mortality, weight changes, hematologic parameters, and urinary protein and found only slight decreases in hemoglobin and erythrocyte count in dogs exposed to high (6 mg/m(3) zirconium) concentrations of zirconium tetrachloride; no histological changes were seen in these animals at autopsy [ACGIH 1986, p. 647].

2. Effects on Humans: In humans, contact of the skin with zirconium or zirconium compounds has caused skin granulomas in the form of linear streaks of small papules; the granulomas occurred after the application of deodorants containing sodium zirconium lactate or of cream containing zirconium oxide [Clayton and Clayton 1981, p. 2055]. Zirconium workers have also developed pulmonary granulomas after exposure to zirconium [Gosselin, Smith, and Hodge 1984, p. II-149]. One chemical engineer who had 7 years of zirconium exposure developed a pulmonary granulomatous disease; examination of all other employees in the same plant revealed no pulmonary granulomas, and the engineer's condition was attributed to prior beryllium exposure [Parmeggiani 1983, p. 2343]. Clinical examination of 22 zirconium reduction processing workers exposed for 1 to 5 years to an unspecified concentration of zirconium fumes revealed no exposure-related abnormalities [Clayton and Clayton 1981, p. 2058].

* Signs and symptoms of exposure

1. Acute exposure: The signs and symptoms of skin contact with zirconium compounds include small, reddish-brown papules in linear streaks on the abraded skin.

2. Chronic exposure: The signs and symptoms of chronic exposure to zirconium or its compounds may include the development of pulmonary granulomas.

* Emergency procedures:

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate the following emergency procedures:

1. Eye exposure: If zirconium or a zirconium compound gets into the eyes, immediately flush the eyes with large amounts of water for a minimum of 15 minutes, lifting the lower and upper lids occasionally. If irritation persists, get medical attention as soon as possible.

2. Skin exposure: If zirconium or a zirconium compound contacts the skin, the contaminated skin should be washed with soap and water. If irritation persists, get medical attention.

3. Inhalation: If zirconium dust is inhaled, move the victim at once to fresh air and get medical care as soon as possible. If the victim is not breathing, perform cardiopulmonary resuscitation; if breathing is difficult, give oxygen. Keep the victim warm and quiet until medical help arrives.

4. Ingestion: If a zirconium compound is ingested, give the victim several glasses of water to drink and then induce vomiting by having the victim touch the back of the throat with the finger or by giving syrup of ipecac as directed on the package. Do not force an unconscious or convulsing person to drink liquids or to vomit. Get medical help immediately. Keep the victim warm and quiet until medical help arrives.

5. Rescue: Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the Material Safety Data Sheet required by OSHA's Hazard Communication Standard, 29 CFR 1910.1200). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve zirconium and zirconium compounds and lead to worker exposures to this substance:

Zirconium:

- Milling of zirconium-bearing ores
- Use as a deoxidizer in metallurgy, as a substitute for platinum, to prime explosives, in flashlight powders, and in the construction of rayon spinnerets
- Use as a foundry sand, an abrasive, a pigment, and a component of zirconium refractory compositions for laboratory crucibles
- Use as an opacifier and polishing powder in lenses, television tubes, ceramic glazes, and enamels
- Use as a lining material for glass furnaces, in dies for the extrusion of metals, as a spout lining for pouring metals, and in linings for reaction vessels and pumps and piping systems for chemical processes
- Use as a catalyst in alkyl and alkenyl hydrocarbon manufacture, a stabilizer in silicon rubbers, and as a gemstone
- Use as a reflective surfacing agent on satellites, in special welding fluxes, and in acid manufacturing plants
- Use as a gas getter in the manufacture of high vacuum tubes and as a filler in photographic flash bulbs

Zirconium acetate:

- Use as a precipitating agent for gelatin and starch on textiles and paper and as a water repellant for textiles
- Use in waterproofing textiles and in precipitating proteins, starches, etc. for textile and paper coatings

Zirconium carbide:

- Manufacture of tools used to cut metals

Zirconium chloride:

- Use as a starting material in the synthesis of organic derivatives of zirconium and as a catalyst in the condensation of ethylene

Zirconium diboride:

- Manufacture of tools used to cut metals
- Use as a thermocouple jacket in open-hearth furnaces

Zirconium hydride:

- Use as a hydrogenation catalyst, in powder metallurgy, and in the vacuum tube industry

Zirconium nitrate:

- Use as a preservative

Zirconium oxide:

- Use in ceramics and in high-temperature batteries

Zirconium oxychloride:

- Use as a cosmetics, textile, and grease additive; in dyes; and as a chemical reagent

Zirconium tetrachloride:

- Use as a textile water repellant and tanning agent

Methods that are effective in controlling worker exposures to zirconium and zirconium compounds, depending on the feasibility of implementation, are

- Process enclosure,
- Local exhaust ventilation,
- General dilution ventilation, and
- Personal protective equipment.

The following publications are good sources of information on control methods:

1. ACGIH [1986]. Industrial ventilation--a manual of recommended practice. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. Industrial ventilation--a self study companion. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. Design of industrial ventilation systems. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. Engineering design for control of workplace hazards. New York, NY: McGraw-Hill.

5. Plog BA [1988]. Fundamentals of industrial hygiene. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety or health, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene

monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplemer not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the period of employment, and (3) at the tin of job transfer or termination.

* Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to zirconium or a zirconium compound, the examining physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the respiratory system and skin. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by NIOSH and the American Thoracic Society.

A preplacement medical evaluation is recommended to assess an individual's suitability for employment at a specific job and to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to zirconium or a zirconium compound at or below the prescribed exposure limit. The examining physician should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the respiratory system or skin.

* Periodic medical examinations and biological monitoring

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to exposure to zirconium or a zirconium compound. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of zirconium and zirconium compounds on the respiratory system or skin. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for zirconium or for zirconium compounds.

* Medical examinations recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination to determine the worker's medical status at the end of his or her employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT PROCEDURES

Determination of a worker's exposure to airborne zirconium or a zirconium compound (measured as zirconium) is made using a tared low ash polyvinyl chloride filter (5 microns). Samples are collected at a maximum flow rate of 2 liters per minute until a maximum air volume of 960 liters is collected. The sample is then analyzed gravimetrically. This method has a sampling and analytical error of 0.01 and is included in the **OSHA Computerized Information System** [OSHA 1985] and the **OSHA Chemical Information Manual** [OSHA 1987]. NIOSH has a sampling and analytical method for zirconium compounds (measured as zirconium) that involves filter collection, acid digestion, and atomic absorption spectrophotometric analysis and is described in Method S185 of the **NIOSH Manual of Analytical Methods,** 2nd edition, Volume 3 [NIOSH 1977].

Controls

PERSONAL HYGIENE PROCEDURES

If zirconium or a zirconium compound contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing contaminated with zirconium or a zirconium compound should be removed immediately, and provisions should be ma for the safe removal of the chemical from the clothing. Persons laundering the clothes should be informed of the hazardous properties of zirconium and zirconium compounds, particularly their potential to cause irritation of the skin.

A worker who handles zirconium or a zirconium compound should thoroughly wash hands, forearms, and face with soap and

water before eating, using tobacco products, or using toilet facilities.

Workers should not eat, drink, or use tobacco products in areas where zirconium or a zirconium compound is handled, processed, or stored.

STORAGE

Zirconium or zirconium compounds should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's Hazard Communication Standard [29 CFR 1910.1200]. Dry powdered zirconium is ignitable at room temperature by static electricity or simple friction and should therefore be stored under a dry argon atmosphere. Powdered zirconium or zirconium hydride should be handled either in a dry, inert atmosphere or under water. Containers of powdered zirconium should be examined regularly for signs of rust or moisture. All lines and equipment used near powdered zirconium or zirconium hydride must be bonded and grounded, and all tools used with these substances must be nonsparking. A supply of powdered limestone, dry sand, Fuller's earth, or a metal extinguishant must be kept readily available to extinguish fires involving these substances. Containers of zirconium or a zirconium compound should be protected from physical damage and be separated from incompatible chemicals, water or moisture, heat, sparks, and open flame. Because empty containers that formerly contained zirconium or a zirconium compound may contain product residues, they should be handled appropriately.

SPILLS AND LEAKS

In the event of a spill or leak involving zirconium or a zirconium compound, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material.

2. Notify safety personnel.

3. Remove all sources of heat and ignition.

4. Ventilate potentially explosive atmospheres.

5. Use cleanup methods that minimize the generation of dust.

6. Only nonsparking tools may be used to clean up powdered zirconium, zirconium hydride, or other flammable zirconium compounds.

7. Spills of powdered zirconium must be kept wet at all times to avoid ignition and must be collected and stored under water in a metal drum for later disposal.

8. Zirconium hydride spills should be covered with limestone before being cleaned up; use a clean shovel and place the material into a clean, dry container; cover and remove the container from the spill area.

EMERGENCY PLANNING, COMMUNITY RIGHT-TO-KNOW, AND HAZARDOUS WASTE MANAGEMENT REQUIREMENTS

The Environmental Protection Agency's (EPA's) regulatory requirements for emergency planning, community right-to-know, and hazardous waste management may vary over time. Users are therefore advised to determine periodically whether new information is available.

* Emergency planning requirements

    Zirconium and zirconium compounds are not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (Title III).

* Reportable quantity requirements for hazardous releases

    Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR Part 355.40] to notify the National Response Center of an accidental release of zirconium or a zirconium compound; there is no reportable quantity for these substances.

* Community right-to-know requirements

    Employers are not required by Section 313 of the Superfund Amendments and Reauthorization Act (SARA) to

submit a Toxic Chemical Release Inventory form (Form R) to EPA reporting the amount of zirconium or zirconium compounds emitted or released from each facility annually.

* Hazardous waste management requirements

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity, as defined in 40 CFR 261.21-261.24. Under the Resource Conservation and Recovery Act (RCRA), EPA has specifically listed many chemical wastes as hazardous. Although zirconium and its compounds are not specifically listed as a hazardous waste under RCRA, EPA requires employers to treat any waste as hazardous if it exhibits any of the characteristics discussed above.

Providing more information about the removal and disposal of specific chemicals is beyond the scope of this guideline. EPA, U.S. Department of Transportation, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (202) 382-3000 (in Washington, D.C.) or toll-free at (800) 424-9346 (outside Washington, D.C.). In addition, relevant State and local authorities should be contacted for information on any requirements they may have for the waste removal and disposal of this substance.

RESPIRATORY PROTECTION

* Conditions for respirator use

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of zirconium or a zirconium compound exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

* Respiratory protection program

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's Respiratory Protection Standard [29 CFR 1910.134]. Such a program must include respirator selection (see Table 1), an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the **NIOSH Respirator Decision Logic** [NIOSH 1987c] and the **NIOSH Guide to Industrial Respiratory Protection** [NIOSH 1987a].

Table 1 lists the respiratory protection that NIOSH recommends for workers exposed to zirconium or a zirconium compound. The recommended protection may vary over time because of changes in the exposure limit for these substances or in respirator certification requirements. Users are therefore advised to determine periodically whether new information is available.

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn to prevent skin contact with zirconium or a zirconium compound. Flame-resistant gloves and chemical- and flame-resistant protective clothing (aprons, coveralls, etc.) are recommended when workers handle powdered zirconium, zirconium hydride, or other flammable zirconium compounds. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. No reports have been published on the resistance of various protective clothing materials to permeation by zirconium or a zirconium compound. If permeability data are not readily available, protective clothing manufacturers should be requested to provide information on the best chemical protective clothing for workers to wear when they are exposed to zirconium or a zirconium compound.

If zirconium or a zirconium compound is dissolved in water or an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or faceshields should be worn during operations in which zirconium or a zirconium compound might contact the eyes (e.g., through dust particles or splashes of solution). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with zirconium or a zirconium

compound. Contact lenses should not be worn if the potential exists for exposure to any of these substances.

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Reference Table

Table 1
NIOSH recommended respiratory protection for workers exposed to zirconium or a zirconium compound*

Condition	Minimum respiratory protection**
Airborne concentration of zirconium or a zirconium compound (measured as zirconium):	
5 to 25 mg/m(3) (5 X PEL)	Single-use or quarter mask respirator
5 to 50 mg/m(3) (10 X PEL)	Any air-purifying, half-mask respirator equipped with any type of particulate filter (except single-use respirators), or Any air-purifying, full-facepiece respirator equipped with any type of particulate filter, or Any supplied-air respirator equipped with a half mask and operated in a demand (negative-pressure) mode
5 to 125 mg/m(3) (25 X PEL)	Any powered, air-purifying respirator equipped with a hood or helmet and any type of particulate filter, or Any supplied-air respirator equipped with a hood or helmet and operated in a continuous-flow mode
5 to 250 mg/m(3) (50 X PEL)	Any air-purifying, full-facepiece respirator equipped with a high-efficiency filter, or Any powered, air-purifying respirator equipped with a tight-fitting facepiece and a high-efficiency filter Any supplied-air respirator equipped with a full facepiece and operated in a demand (negative-pressure) mode, or Any supplied-air respirator equipped with a tight-fitting facepiece and operated in a continuous-flow

	mode, or Any self-contained respirator equipped with a full facepiece and operated in a demand (negative-pressure) mode
5 to 500 mg/m(3) (100 X PEL)	Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode
Entry into IDLH(+) or unknown concentrations	Any self-contained respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode, or Any supplied-air respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode
Firefighting	Any self-contained respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode
Escape	Any air-purifying, full-facepiece respirator equipped with a high-efficiency filter, or Any escape-type, self-contained breathing apparatus with a suitable service life (number of minutes required to escape the environment)

* The OSHA PEL is 5 mg/m(3) as an 8-hour TWA. No NIOSH REL has been issued.

** Only NIOSH/MSHA-approved equipment should be used. Also note the following:

1. Respirators accepted for use at higher concentrations may be used at lower concentrations; respirators must not, however, be used at concentrations higher than those for which they are approved.

2. Air-purifying respirators may not be used in oxygen-deficient atmospheres or in airborne concentrations that are immediately dangerous to life or health (IDLH).

(+) The concentration of zirconium or a zirconium compound that is immediately dangerous to life and health (IDLH) is 500 mg/m(3) [NIOSH 1987b].

Introduction | **Applicability** | **Recognition** | **Evaluation** | **Controls** | **References** | **Bibliography** | **Reference Table**

MATERIAL SAFETY DATA SHEET

I. PRODUCT IDENTIFICATION

Manufacturer/Supplier:
Metals
Benson Way, Ashland, OR 97520
Toll Free (800) 638-2581 * Fax (541) 488-8313
E-Mail: sales@espimetals.com

Trade Name: Zirconium
Chemical Nature: Metallic Element
Formula: Zr
CAS Number: 7440-67-7

II. HAZARDOUS INGREDIENTS

Hazardous Component: Zirconium
% : 0-100
OSHA/PEL: 5 mg/m^3
ACGIH/TLV: 10 mg/m^3

HMIS Ratings (Sponge or Powder): Health: 2 **Flammability:** 4 **Reactivity:** 0 **Equip:** F: glasses, gloves, apron, respirator

III. PHYSICAL DATA

Boiling Point: 4377 °C
Melting Point: 1852 °C
Specific Gravity: 6.506 g/cc
Vapor Pressure: N/A
Vapor Density: N/A
Solubility in H_2O: Insoluble
Appearance and Odor: Metallic gray or silver-gray, odorless.
% Volatile: N/A

IV. FIRE AND EXPLOSION HAZARDS DATA

Autoignition Temperature: Solid metal will not ignite. High surface area material such as 10 micron powder may autoignite at room temperature. Fine chips, turnings, or grinding dust produced from this metal are flammable. Ignition point for powder varies from 200 °C to above 500 °C depending on particle size.

Minimum Explosible Concentration (g/m^3): Less than 100. Varies with particle size.
Extinguishing Media: Dry table salt. Type D fire extinguisher. DO NOT USE water, carbon dioxide or halocarbon extinguishing agent.
Special Firefighting Procedures: If metal fines become ignited it is advisable to allow the material to burnout. Fire can be controlled by smothering with dry table salt or using Type D dry-powder fire extinguisher material. Wear reflective heat-resistant suit.
Unusual Fire & Explosion Hazard: Do not spray water on burning zirconium. Carbon dioxide is not effective in extinguishing burning zirconium.

If a fire starts in a mass of wet metal fines, the initial fire may be followed by an explosion. Therefore, when in doubt, personnel should retire and not attempt to extinguish the fire. The explosive characteristic of such material is caused by the steam and hydrogen generated within the burning mass.

Spontaneously combustible in dry powder form. Flammable and explosive as dust or powder, also in the form of borings and shavings. Zirconium metal is a very dangerous fire hazard in the form of dust when exposed to heat, flame or by chemical reaction with oxidizing agents. May be an explosion hazard in the form of dust by chemical reaction with air, alkali hydroxides, alkali metal chromates, dichromates, molybdates, sulfates, tungstates, borax, CCl_4, copper oxide, lead, lead oxide, phosphorous, $KClO_3$, KNO_3, nitryl fluoride. May be extremely sensitive to shock, and static electricity may cause spontaneous ignition.

V. HEALTH HAZARD INFORMATION

Effects of Exposure:

To the best of our knowledge the chemical, physical and toxicological properties of zirconium have not been thoroughly investigated and recorded.

Zirconium compounds are not an important industrial poison. Most zirconium compounds in common use are insoluble and considered inert. Pulmonary granuloma in zirconium workers has been reported.

Acute Effects:

Inhalation: May cause irritation to the respiratory tract, mucous membranes or the nose and throat.
Ingestion: May cause irritation to the gastrointestinal tract.
Skin: May cause irritation.
Eye: May cause irritation.

Chronic Effects: Skin: May cause skin granulomas. No other chronic health effects recorded.

Target Organs: May affect the respiratory system and skin.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove victim to fresh air, keep warm and quiet, give oxygen if breathing is difficult, seek medical attention if symptoms persist.
INGESTION: Give 1-2 glasses or milk or water and induce vomiting; seek medical attention if symptoms persist. Never induce vomiting or give anything by mouth to an unconscious person.
SKIN: Remove contaminated clothing, brush material off skin, wash affected area with mild soap and water, seek medical attention if symptoms persist.
EYE: Flush eyes with lukewarm water, lifting upper and lower eyelids, for at least 15 minutes. Seek medical attention if symptoms persist.

VI. REACTIVITY DATA

Stability: Stable
Conditions to Avoid: High temperatures, sources of ignition. May be extremely sensitive to shock and static electricity. May be an explosion hazard in the form of dust by chemical reaction with air.
Incompatibility (Material to Avoid): Strong oxidizing agents, air, alkali hydroxides, alkali metal chromates, dichromates, molybdates, sulfates, tungstates, borax, CCL_4, copper oxide, lead, lead oxide, phosphorus, $KClO_3$, KNO_3, and acids. Zirconium metal is rapidly dissolved by hydrofluoric acid or hydrofluoric-nitric acid mixtures. Above 200 °C, zirconium reacts exothermically with halogen gases, fluorine, chlorine, bromine, iodine, and halocarbons, including carbon tetrachloride, carbon tetrafluoride and Freons. Nitryl-Fluoride, FNO_2 will initiate a reaction with zirconium metal at room temperature to produce a glowing or white incandescence.
Hazardous Decomposition Products: Zirconium metal does not decompose. The above reactions with incompatible materials will generate hazardous reactions products such as flammable hydrogen, toxic fumes of nitrogen oxides, or corrosive zirconium halide vapors.
Hazardous Polymerization: Will not occur

VII. SPILL OR LEAK PROCEDURES

Steps to Be Taken in Case Material Is Released or Spilled: Wear appropriate respiratory and protective equipment specified in section VIII. Sweep or scoop up and place in a closed container for proper disposal. Stay aware of fire hazard. Avoid all ignition sources. Do not generate dust.
Additional Protective Measures: Evaluate each situation for possibility of flash burns. Work areas must be periodically cleaned to avoid accumulation of flammable dust. If dust has accumulated, wear reflective heat-resistant suit while cleaning.
Waste Disposal Method: Dispose of in accordance with all State, Federal and Local regulations.

VIII. SPECIAL PROTECTION INFORMATION

Respiratory Protection: Use NIOSH-approved respirator if process will generate dust.
Ventilation: General exhaust is recommended.
Protective Gloves: Use of gloves advisable to avoid cuts.
Eye Protection: Safety glasses.
Other Protective Clothing or Equipment: If dust has accumulated, wear reflective heat-resistant suit while cleaning.

IX. SPECIAL PRECAUTIONS

Precautions to Be Taken in Handling and Storage:
Machining of zirconium may result in fine turnings or chips. Any material with a dimension less than 0.0625" (1/16") or a cross section less than 0.0078" square (1/16 x 1/8), if present in any quantity, can be ignited and can sustain combustion. Keep away from any source of ignition. Keep fine turnings completely dry, or very wet. If wet, the water content should be more than 25% by weight for maximum safety in handling. Severe explosions can result from ignition of zirconium powder or machining fines containing moisture in the concentration range of 5 to 10%.(Sponge) Avoid ignition sources and high temperatures. Long term storage should be in argon-filled steel drums with tight fitting clamp-on sealable lids. All handling and storage areas should be clearly posted with "Hot Work Area Permit" signs.
Other Precautions: Very finely divided scrap or sawdust, with a dimension less than 0.012", should be considered to be pyrophoric and should not be accumulated. Dispose of these materials daily. In some cases, when the chemical corrosion resistance of zirconium is exceeded, a corrosion product containing fine zirconium particulate can form on the surface of the metal which can be easily ignited. This film can be rendered non-flammable by simple oxidation treatments such as heating to 250 °C for 1 hour or 100 °C for 7 days.

TSCA Listed: Yes
DOT Regulations:
Solid Forms:
Hazard Class: None
Powder:
Hazard Class: 4.2
Identification Number: UN2008
Packing Group: II
Proper Shipping Name: Zirconium powder, dry

The above information is believed to be correct, but does not purport to be all inclusive and shall be used only as a guide. ESPI shall not be held liable for any damages resulting from handling or from contact with the above product.

Issued by: S. Dierks
Date: January 2008

MATERIAL SAFETY DATA SHEET

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Trade Name: Zirconium
Chemical Nature: Metallic Element
Formula: Zr
CAS Number: 7440-67-7

II. HAZARDOUS INGREDIENTS

Hazardous Component: Zirconium
%: 0-100
OSHA/PEL: 5 mg/m^3
ACGIH/TLV: 10 mg/m^3

HMIS Ratings (Sponge or Powder): Health: 2 **Flammability**: 4 **Reactivity**: 0 **Equip**: F: glasses, gloves, apron, respirator

III. PHYSICAL DATA

Boiling Point: 4377 °C
Melting Point: 1852 °C
Specific Gravity: 6.506 g/cc
Vapor Pressure: N/A
Vapor Density: N/A
Solubility in H_2O: Insoluble
Appearance and Odor: Metallic gray or silver-gray, odorless.
% Volatile: N/A

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Extinguishing Media: Dry table salt. Type D fire extinguisher. DO NOT USE water, carbon dioxide or halocarbon extinguishing agent.
Special Firefighting Procedures: If metal fines become ignited it is advisable to allow the material to burnout. Fire can be controlled by smothering with dry table salt or using Type D dry-powder fire extinguisher material. Wear reflective heat-resistant suit.
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V. HEALTH HAZARD INFORMATION

Effects of Exposure:

To the best of our knowledge the chemical, physical and toxicological properties of zirconium have not been thoroughly investigated and recorded.

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EYE: Flush eyes with lukewarm water, lifting upper and lower eyelids, for at least 15 minutes. Seek medical attention if symptoms persist.

VI. REACTIVITY DATA

Stability: Stable
Conditions to Avoid: High temperatures, sources of ignition. May be extremely sensitive to shock and static electricity. May be an explosion hazard in the form of dust by chemical reaction with air.
Incompatibility (Material to Avoid): Strong oxidizing agents, air, alkali hydroxides, alkali metal chromates, dichromates, molybdates, sulfates, tungstates, borax, CCL_4, copper oxide, lead, lead oxide, phosphorus, $KClO_3$, KNO_3, and acids. Zirconium metal is rapidly dissolved by hydrofluoric acid or hydrofluoric-nitric acid mixtures. Above 200 °C, zirconium reacts exothermically with halogen gases, fluorine, chlorine, bromine, iodine, and halocarbons, including carbon tetrachloride, carbon tetrafluoride and Freons. Nitryl-Fluoride, FNO_2 will initiate a reaction with zirconium metal at room temperature to produce a glowing or white incandescence.
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Issued by: S. Dierks
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Zirconium

MATERIAL SAFETY DATA SHEET

I. PRODUCT IDENTIFICATION

Manufacturer/Supplier:

ESPI Metals

1050 Benson Way, Ashland, OR 97520

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HMIS Ratings (Sponge or Powder):

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Flammability: 4

Reactivity: 0

III. PHYSICAL DATA

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Melting Point: 1852 °C

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Contact

ESPI Metals
1050 Benson Way
Ashland, Oregon 97520

541.488.8311 telephone
800.638.2581 toll-free

541.488.8313 fax
800.488.0060 toll-free fax

sales@espimetals.com

Precious Metal Prices

Sep 05, 2012 at 17:15 New York		Price	Change	High
Gold	▼	1693.40	-2.80	1696.30
Silver	▼	32.27	-0.09	32.49
Platinum	▲	1568.00	+2.00	1582.00
Palladium	▲	642.00	+2.00	651.00

Specific Gravity: 6.506 g/cc

Solubility in H_2O: Insoluble

Appearance and Odor: Metallic gray or silver-gray, odorless.

IV. FIRE AND EXPLOSION HAZARDS DATA

Autoignition Temperature: Solid metal will not ignite. High surface area material such as 10 micron powder may autoignite at room temperature. Fine chips, turnings, or grinding dust produced from this metal are flammable. Ignition point for powder varies from 200 °C to above 500 °C depending on particle size.

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Ingestion: May cause irritation to the gastrointestinal tract.

Skin: May cause irritation.

Eye: May cause irritation.

Chronic Effects: Skin: May cause skin granulomas. No other chronic health effects recorded.

Target Organs: May affect the respiratory system and skin.

Medical Conditions Generally Aggravated by Exposure: Pre-existing respiratory disorders.

Carcinogenicity: NTP: No **IARC:** No **OSHA:** No

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove victim to fresh air, keep warm and quiet, give oxygen if breathing is difficult, seek medical attention if symptoms persist.

INGESTION: Give 1-2 glasses or milk or water and induce vomiting; seek medical attention if symptoms persist. Never induce vomiting or give anything by mouth to an unconscious person.

SKIN: Remove contaminated clothing, brush material off skin, wash affected area with mild soap and water, seek medical attention if symptoms persist.

EYE: Flush eyes with lukewarm water, lifting upper and lower eyelids, for at least 15 minutes. Seek medical attention if symptoms persist.

VI. REACTIVITY DATA

Stability: Stable

Conditions to Avoid: High temperatures, sources of ignition. May be extremely sensitive to shock and static electricity. May be an explosion hazard in the form of dust by chemical reaction with air.

Incompatibility (Material to Avoid): Strong oxidizing agents, air, alkali hydroxides, alkali metal chromates, dichromates, molybdates, sulfates, tungstates, borax, CCL_4, copper oxide, lead, lead oxide, phosphorus, $KClO_3$, KNO_3, and acids. Zirconium metal is rapidly dissolved by hydrofluoric acid or hydrofluoric-nitric acid mixtures. Above 200 ^{o}C, zirconium reacts exothermically with halogen gases, fluorine, chlorine, bromine, iodine, and halocarbons, including carbon tetrachloride, carbon tetrafluoride and Freons. Nitryl-Fluoride, FNO_2 will initiate a reaction with zirconium metal at room temperature to produce a glowing or white incandescence.

Hazardous Decomposition Products: Zirconium metal does not decompose. The above reactions with incompatible materials will generate hazardous reactions products such as flammable hydrogen, toxic fumes of nitrogen oxides, or corrosive zirconium halide vapors.

Hazardous Polymerization: Will not occur

VII. SPILL OR LEAK PROCEDURES

Steps to Be Taken in Case Material Is Released or Spilled: Wear appropriate respiratory and protective equipment specified in section VIII. Sweep or scoop up and place in a closed container for proper disposal. Stay aware of fire hazard. Avoid all ignition sources. Do not generate dust.

Additional Protective Measures: Evaluate each situation for possibility of flash burns. Work areas must be periodically cleaned to avoid accumulation of flammable dust. If dust has accumulated, wear reflective heat-resistant suit while cleaning.

Waste Disposal Method: Dispose of in accordance with all State, Federal and Local regulations.

VIII. SPECIAL PROTECTION INFORMATION

Respiratory Protection: Use NIOSH-approved respirator if process will generate dust.

Ventilation: General exhaust is recommended.

Protective Gloves: Use of gloves advisable to avoid cuts.

Eye Protection: Safety glasses.

Other Protective Clothing or Equipment: If dust has accumulated, wear reflective heat-resistant suit while cleaning.

IX. SPECIAL PRECAUTIONS

Precautions to Be Taken in Handling and Storage:

Machining of zirconium may result in fine turnings or chips. Any material with a dimension less than 0.0625" (1/16") or a cross section less than 0.0078" square (1/16 x 1/8), if present in any quantity, can be ignited and can sustain combustion. Keep away from any source of ignition. Keep fine turnings completely dry, or very wet. If wet, the water content should be more than 25% by weight for maximum safety in handling. Severe explosions can result from ignition of zirconium powder or machining fines containing moisture in the concentration range of 5 to 10%. (Sponge) Avoid ignition sources and high temperatures. Long term storage should be in argon-filled steel drums with tight fitting clamp-on sealable lids. All handling and storage areas should be clearly posted with "Hot Work Area Permit" signs.

Other Precautions: Very finely divided scrap or sawdust, with a dimension less than 0.012", should be considered to be pyrophoric and should not be accumulated. Dispose of these materials daily. In some cases, when the chemical corrosion resistance of zirconium is exceeded, a corrosion product containing fine zirconium particulate can form on the surface of the metal which can be easily ignited. This film can be rendered non-flammable by simple oxidation treatments such as heating to 250 °C for 1 hour or 100 °C for 7 days.

TSCA Listed: Yes

DOT Regulations:

Solid Forms:

Hazard Class: None

Powder:

Hazard Class: 4.2

Identification Number: UN2008

Packing Group: II

Proper Shipping Name: Zirconium powder, dry

The above information is believed to be correct, but does not purport to be all inclusive and shall be used only as a guide. ESPI shall not be held liable for any damages resulting from handling or from contact with the above product.

Issued by: S. Dierks

Revised/Verified: January 2008